Applied Magnetic Resonance 2008 vol.33 N4, pages 419-429

Anisotropic phantoms for quantitative diffusion tensor imaging and fiber-tracking validation

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Abstract

Different fiber materials (hemp, linen, viscose rayon, polyamide and dyneema twine) were tested for their suitability as fiber phantoms for diffusion tensor imaging (DTI) calibration on clinical magnetic resonance imaging systems with common diffusion-weighted echo planar imaging sequences. Additionally, the potential for fiber tracking validation of these fiber phantoms was investigated. For phantom manufacturing the fibers were wound up into a bundle of parallel fibers enwrapped by plastic ribbon. The most homogenously distributed fractional anisotropy (FA) values (0.63 ± 0.10) were determined in the dyneema and polyamide (0.3 ± 0.1) fiber phantom. FA values in the viscose, linen and hemp bundles were at high variations (about 0.2 ± 0.10). The dispersion of the direction of the principal eigenvector in the polyamide and dyneema phantom was less than 7°, for the other fiber phantoms it was over 30°. Thus, the presented results may indicate that polyamide- and dyneema-based fiber phantoms provide the opportunity for verification and validation of DTI sequences on clinical scanner. Additionally, they can be applicable for testing the accuracy of fiber tracking algorithms. A strong parallel alignment of the fibers with a constant compression grade of the fiber bundles could be achieved by machine-made production. This could also provide highly reproducible diffusion properties within the anisotropic fiber phantoms. © 2008 Springer-Verlag.

http://dx.doi.org/10.1007/s00723-008-0087-7